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Responses of carbon and water fluxes following drought events in combinations with warming and elevated CO_2

Merete Bang Selsted[1], Kristian R. Albert[2], Per Ambus[1], Anders Michelsen[2], Helge Ro-Poulsen[2], Teis N. Mikkelsen[1], Andreas Ibrom[1]

(1) Biosystems Division, Risø National Laboratory for Sustainable Energy, Technical University of Denmark, merete.bang.selsted@risoe.dk
(2) Terrestrial Ecology, Department of Biology, University of Copenhagen, kristiana@bio.ku.dk

The impact of elevated CO_2, warming and drought on heath ecosystem processes are investigated in the CLIMAITE project closely following the modelled climatic scenario for Denmark in year 2075 [1]. The experiment is unique as it evaluates the interactions between drivers on ecosystem processes across scales ranging from ecosystem to leaf gas-exchange, primary production and biodiversity, in order to unravel the complex multi-factor impacts on water, carbon and nitrogen cycles.

Here we focus on the recovery after drought as an example of an extreme event, which is expected to become more frequent in the future. To understand how quickly the ecosystem recovers following drought we intensively monitored plant carbon uptake, plant water consumption, soil activity and carbon release before, during, and after drought events. Water shortage was observed to decrease plant carbon uptake and limit the soil carbon release, whereas both processes increased when soil water was not limiting. Moreover the cover and biomass of the dominant grass *Deschampsia flexuosa* strongly decreased in response to drought. Plant carbon uptake was increased by elevated CO_2 during and after the drought, but plant species differed in the response to re-wetting. Regeneration measured as enhanced plant biomass and carbon uptake increased significantly more in the drought treatments compared to controls for grass (*Deschampsia flexuosa*) and particular when combined with elevated CO_2. The dwarf shrub *Calluna vulgaris* recovered to the same extent in drought and control plots in response to rewetting. Soil respiration was found to recover after the first following rain event. Only plots with drought in combination with a permanent temperature treatment might show a longer recovery period. It seems that temperature in combination with drought has a negative effect on soil respiration, whereas elevated CO_2 might have the opposite effect and compensates for the negative drought effect.

Therefore the balance and between water shortage and re-wetting potentially impact the source and sink strength of the ecosystem. To illustrate the dynamics of these counteracting processes we present several other examples of response patterns from drought periods differing in intensity and length, from year 2006, 2007, and 2008. In addition we present synthesis results based on modelling of the net ecosystem impacts on carbon and water fluxes in response to drought and re-wetting.

[1] T.N. Mikkelsen *et al*., *Functional Ecology,* 2008, 22(1), 185-195.